NS 102 Lecture 11

The Well Tempered Cosmology Class

Open:

Brandenberg Concerto #6 in B^b major BWV 1051

J. S. Bach

Close:

We Are All Made of Stars

Moby

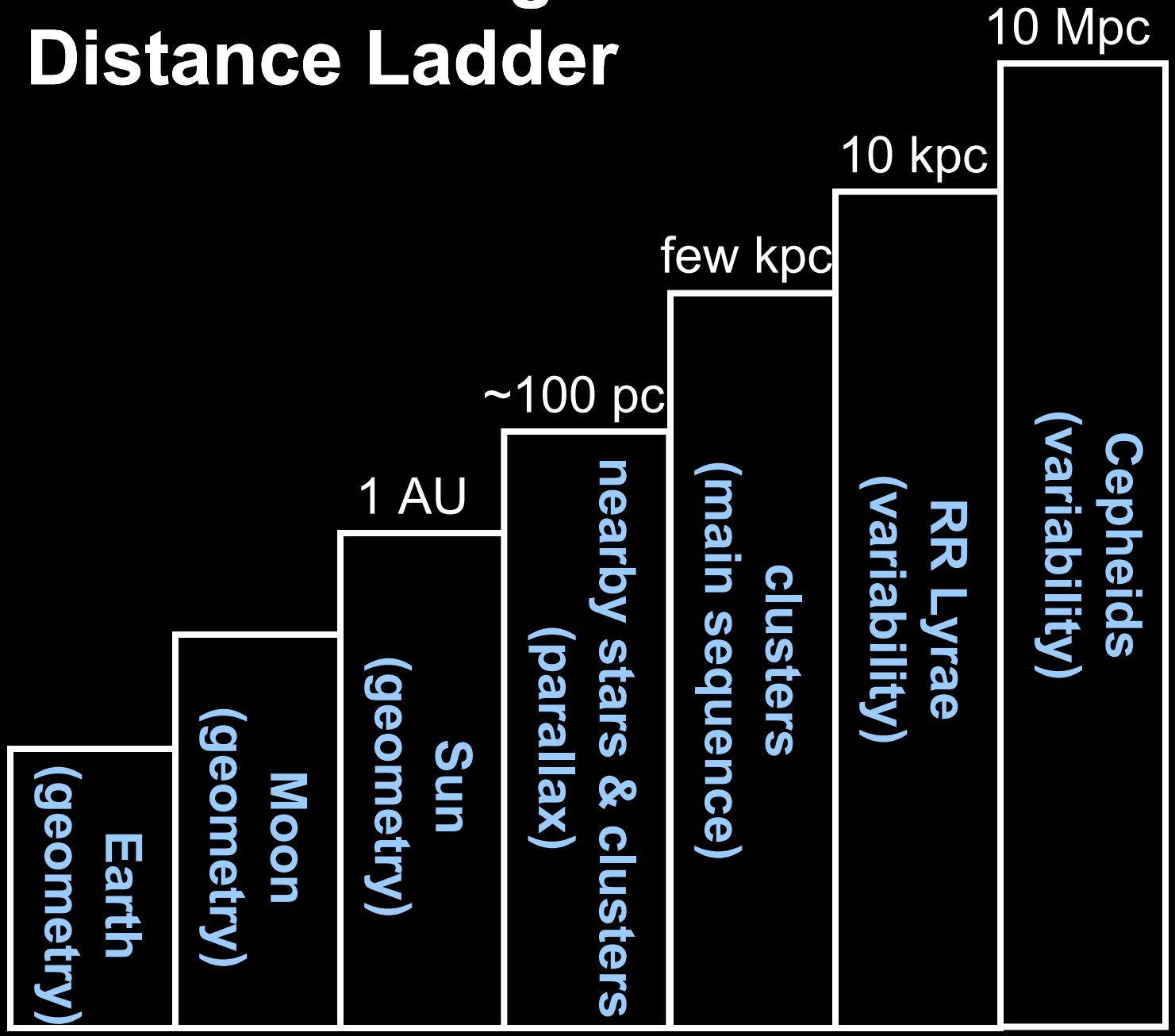
Johann Sebastian Bach (1685-1750)

GnatSigh News
(all the news that fits)

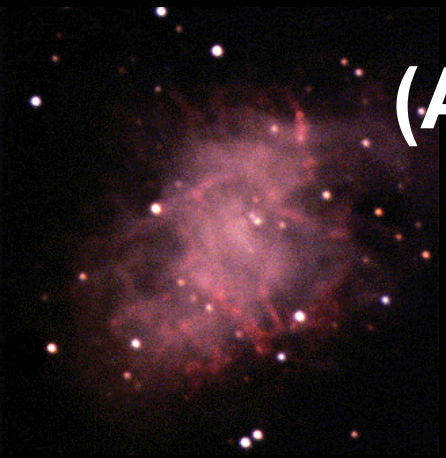
- Website http://home.fnal.gov/~rocky/NS102/
- Messier Objects
  http://www.seds.org/messier/
- Today: Shapley-Curtis debate. Shapley-Curtis information at
  http://antwrp.gsfc.nasa.gov/diamond_jubilee/debate.html
- Well tempered
  http://www.bachfaq1.orgf/welltemp.html
- Original composition "Car horn in A^b"

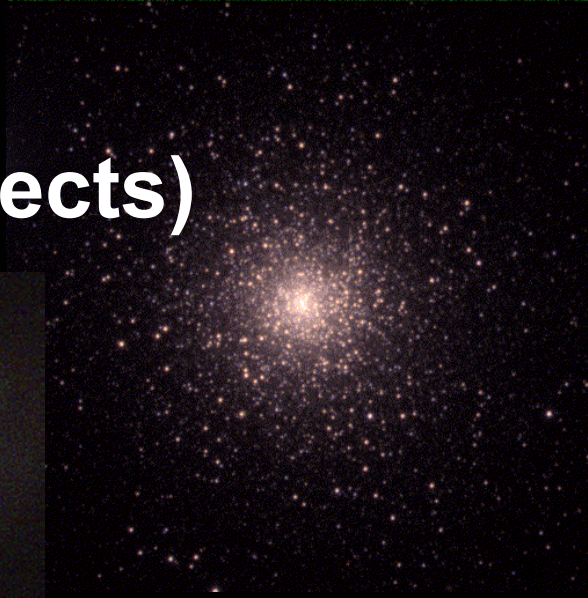
Lab this week: Non-Euclidean Geometry

The Cosmological Distance Ladder

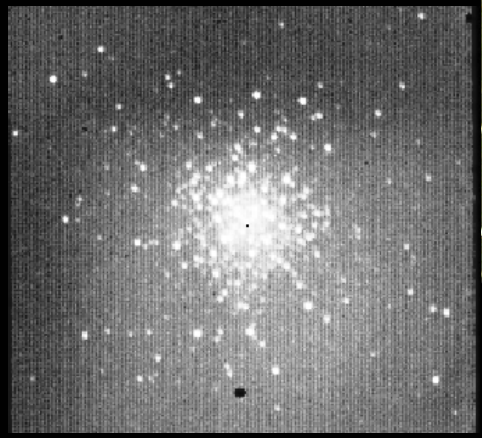


Clouds in the Sky
(A Mess of Messier Objects)

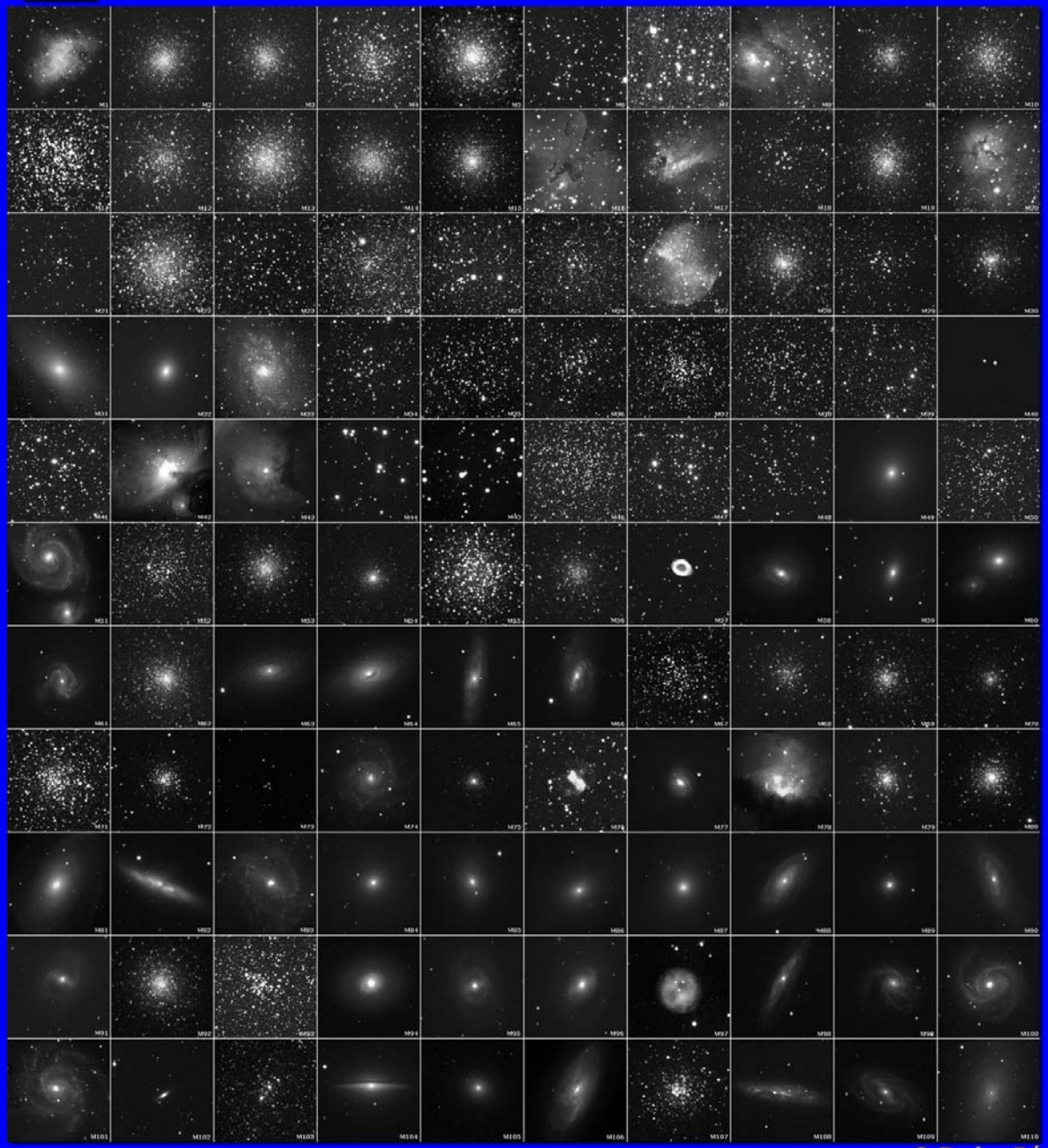


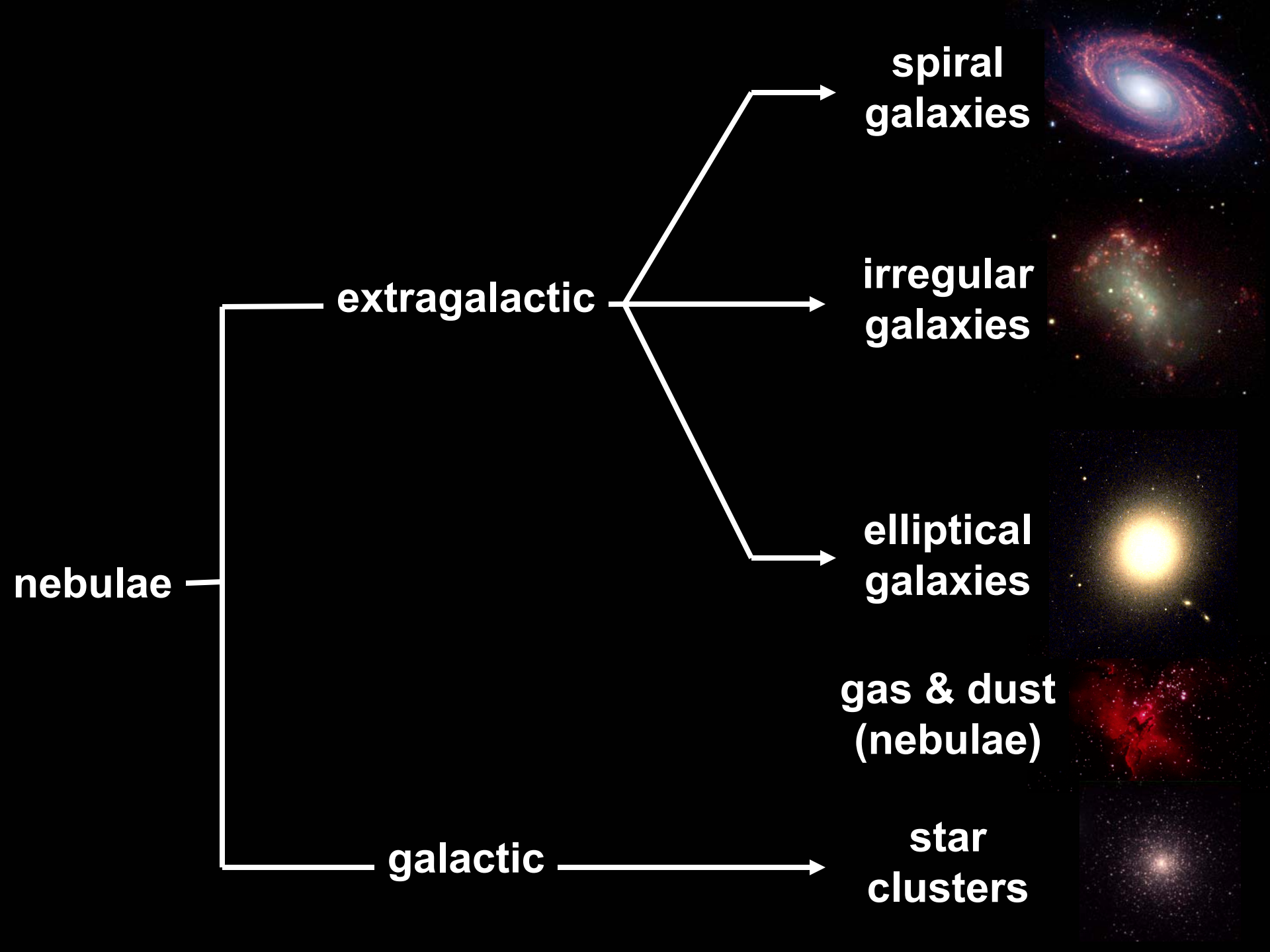




MESSIER CATALOGUE




nebulae
extragalactic
galactic
spiral galaxies
irregular galaxies
elliptical galaxies
gas & dust (nebulae)
star clusters

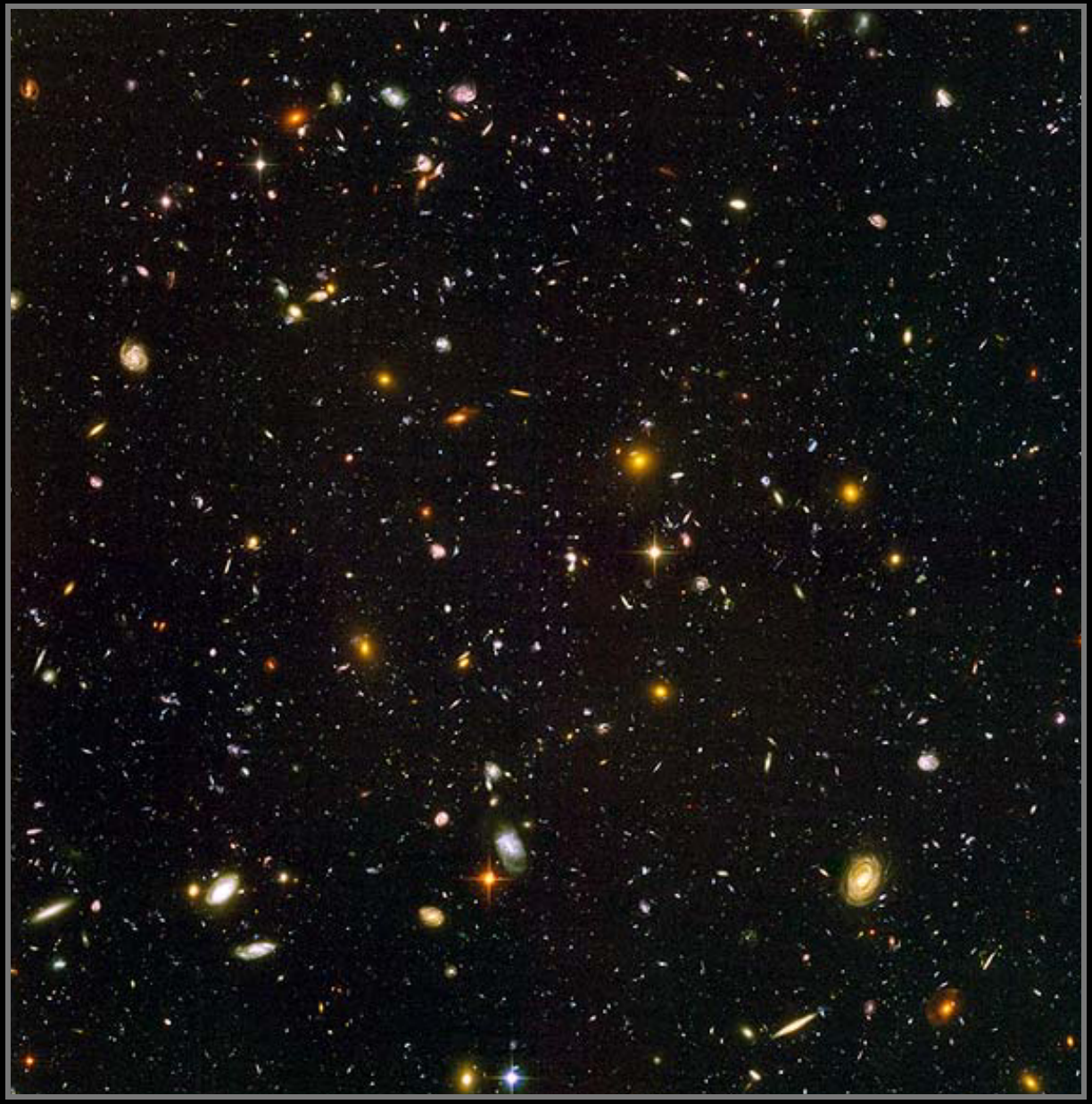
Eagle Nebula

The composition of the universe

Hubble Ultradeep Field

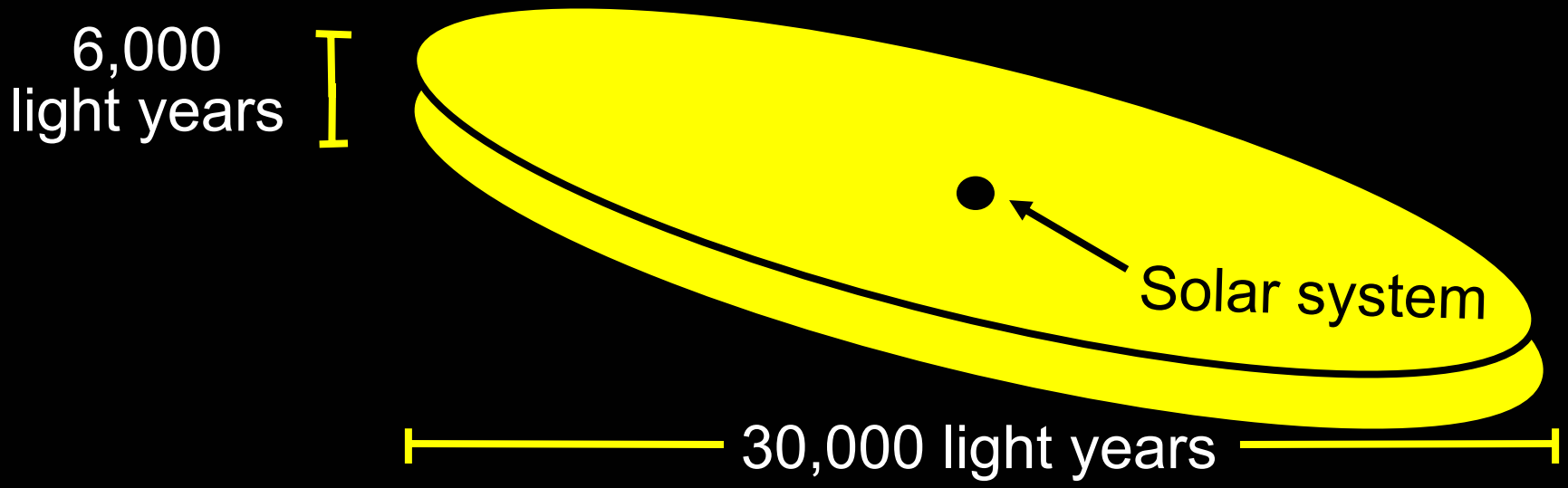
10,000 here →

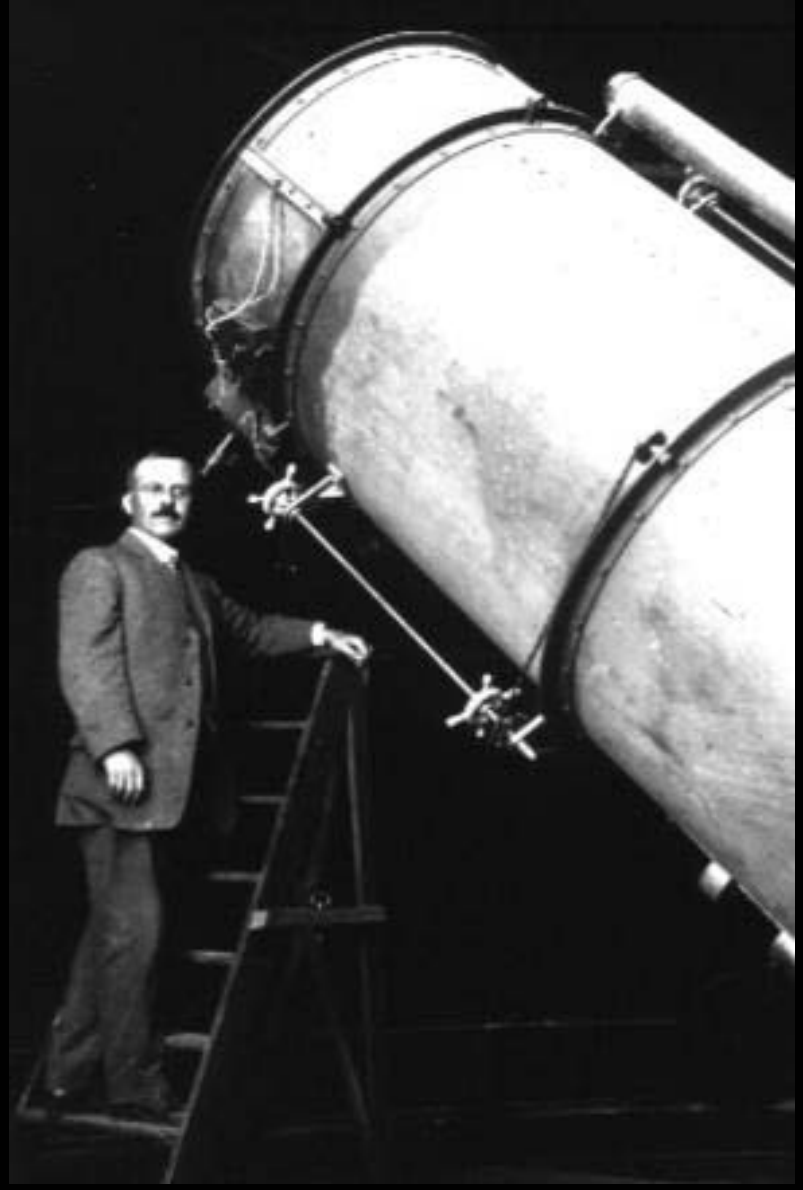
50 thousand million over entire sky



A view of the universe, circa 1905 A.D.

Kapteyn Universe





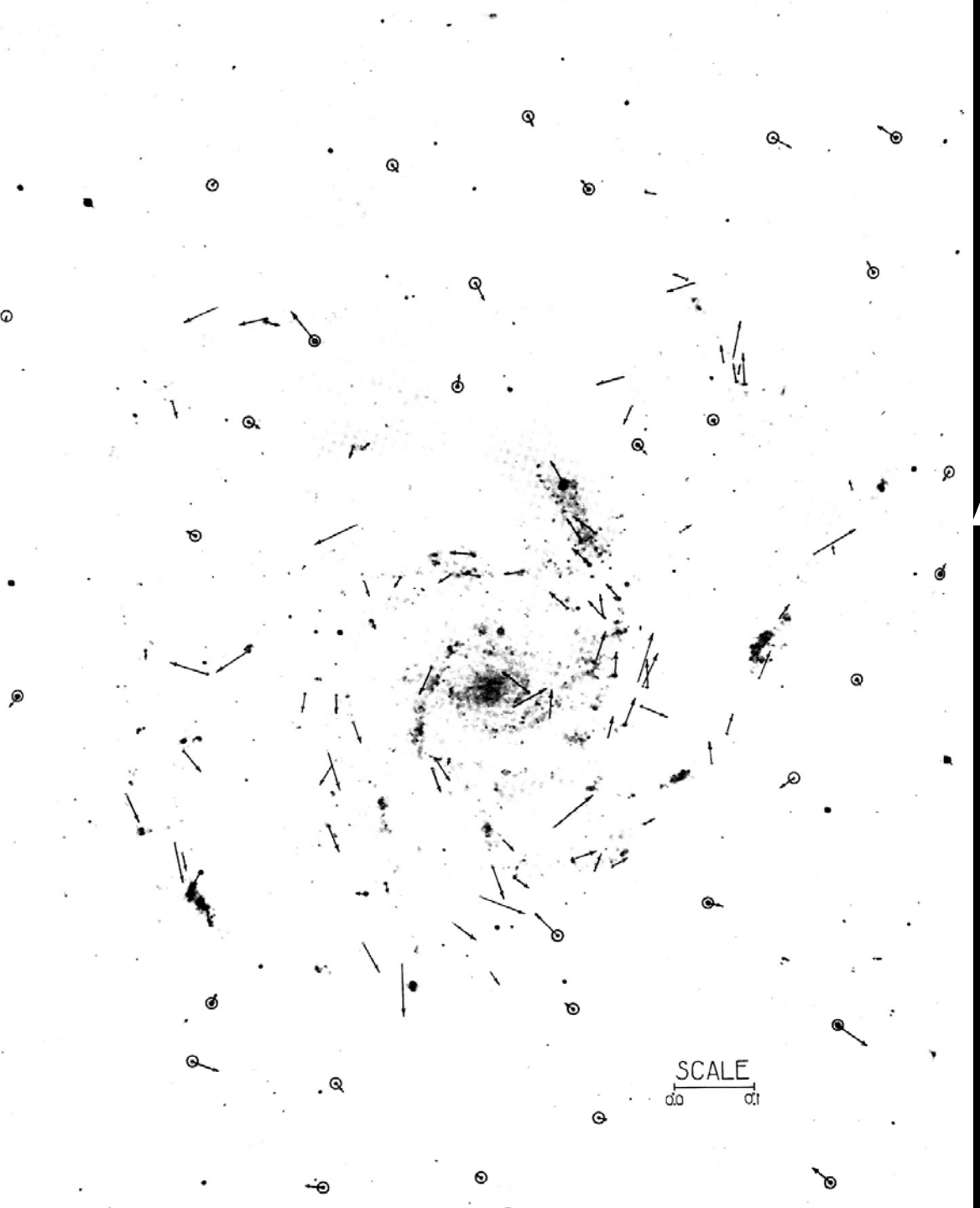
Heber Curtis
1872 - 1942

Harlow Shapley
1885 - 1972

Talking points in the Great Debate

1. Rotation of M101
2. Variable stars
3. Stars or gas
4. Spatial distribution & velocity

M101



Adriaan van Maanen
1916

M101

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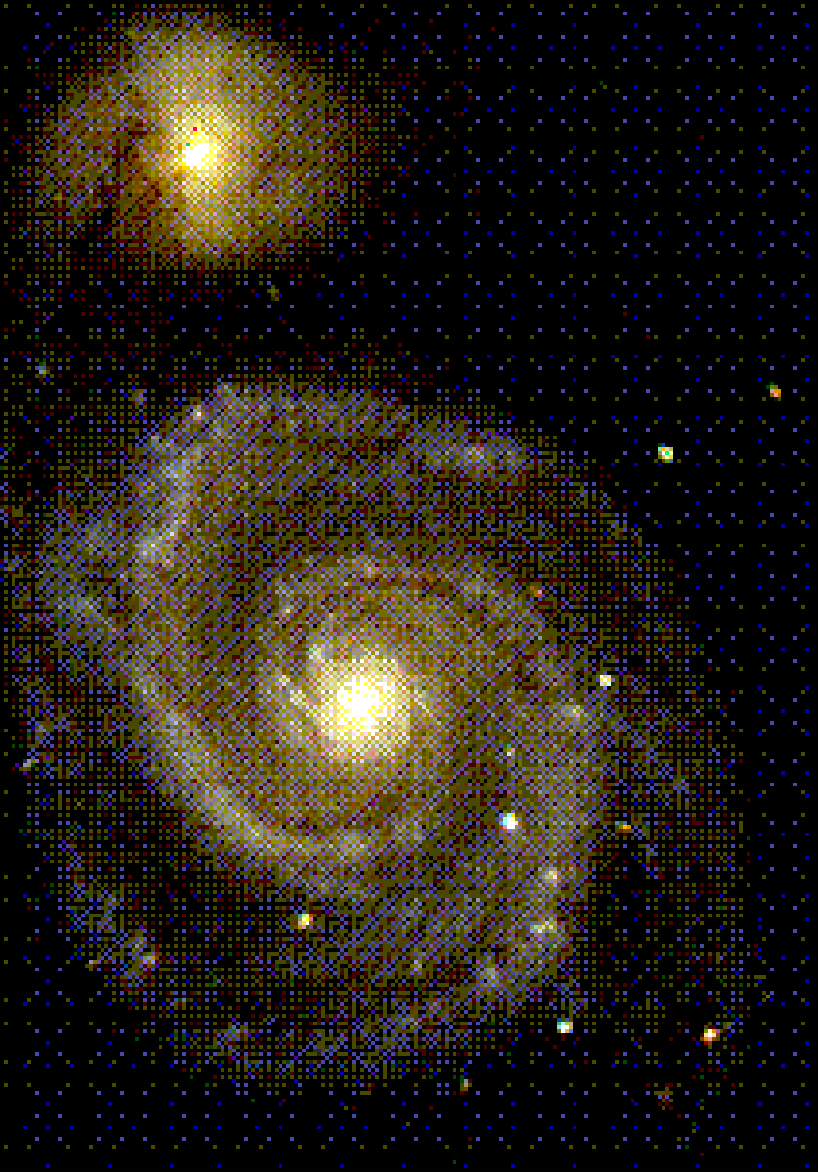

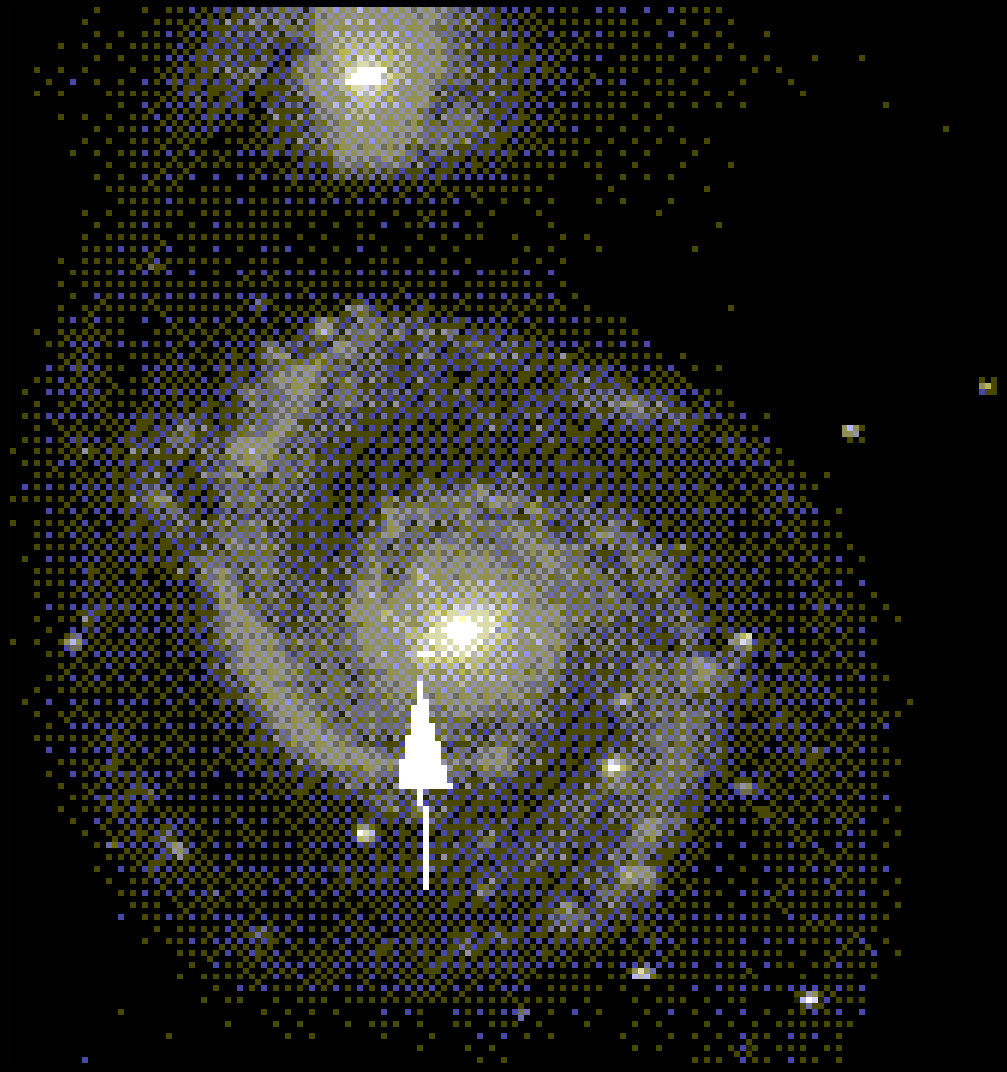

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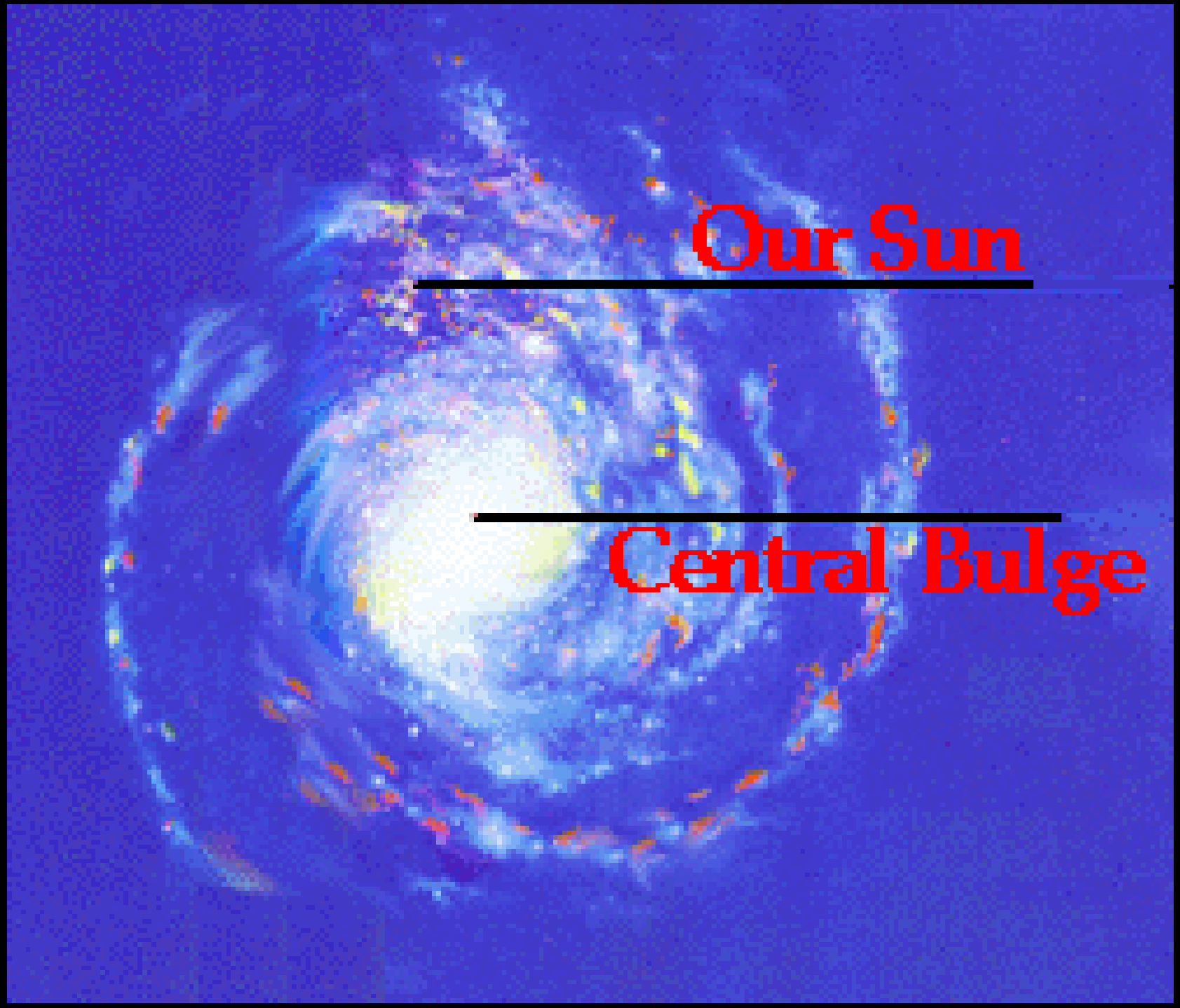
Our Sun
Central Bulge

Talking points in the Great Debate

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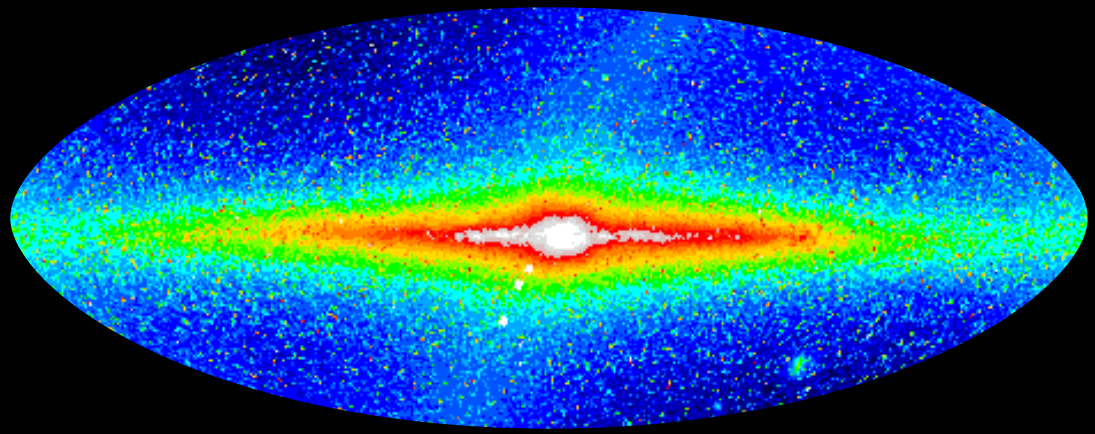


Dust in the galactic plane

Edwin Hubble
1884 - 1953

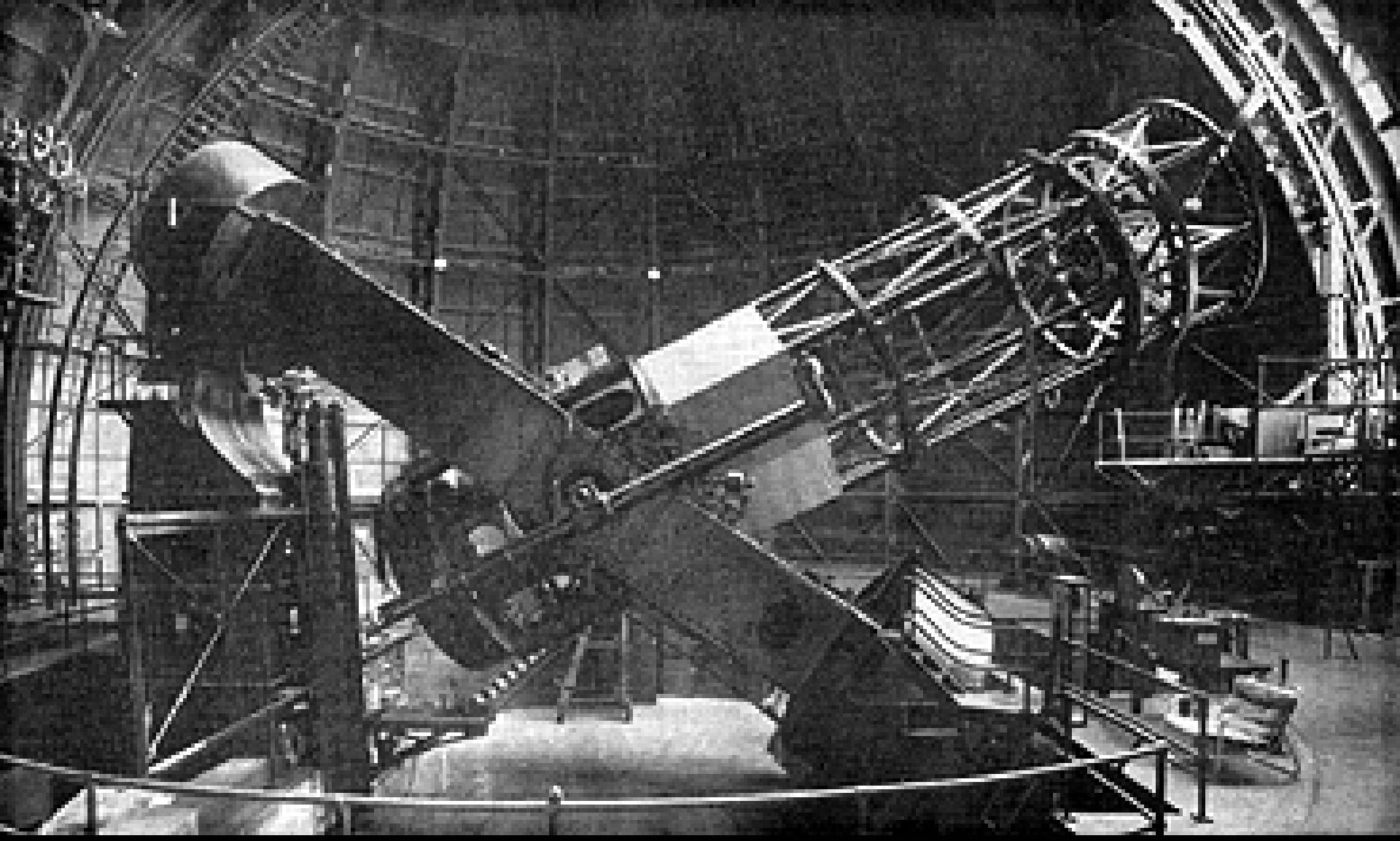
University of Chicago 1909 National Champions

Two famous Rhodes Scholars:

Politics is for the moment; an equation is forever.

A. Einstein

Einstein at Yerkes, May 6, 1921



100-inch Hooker Telescope on Mt. Wilson

Hubble's Hooker Chair

TIME

THE WEEKLY NEWSMAGAZINE

ASTRONOMER HUBBLE

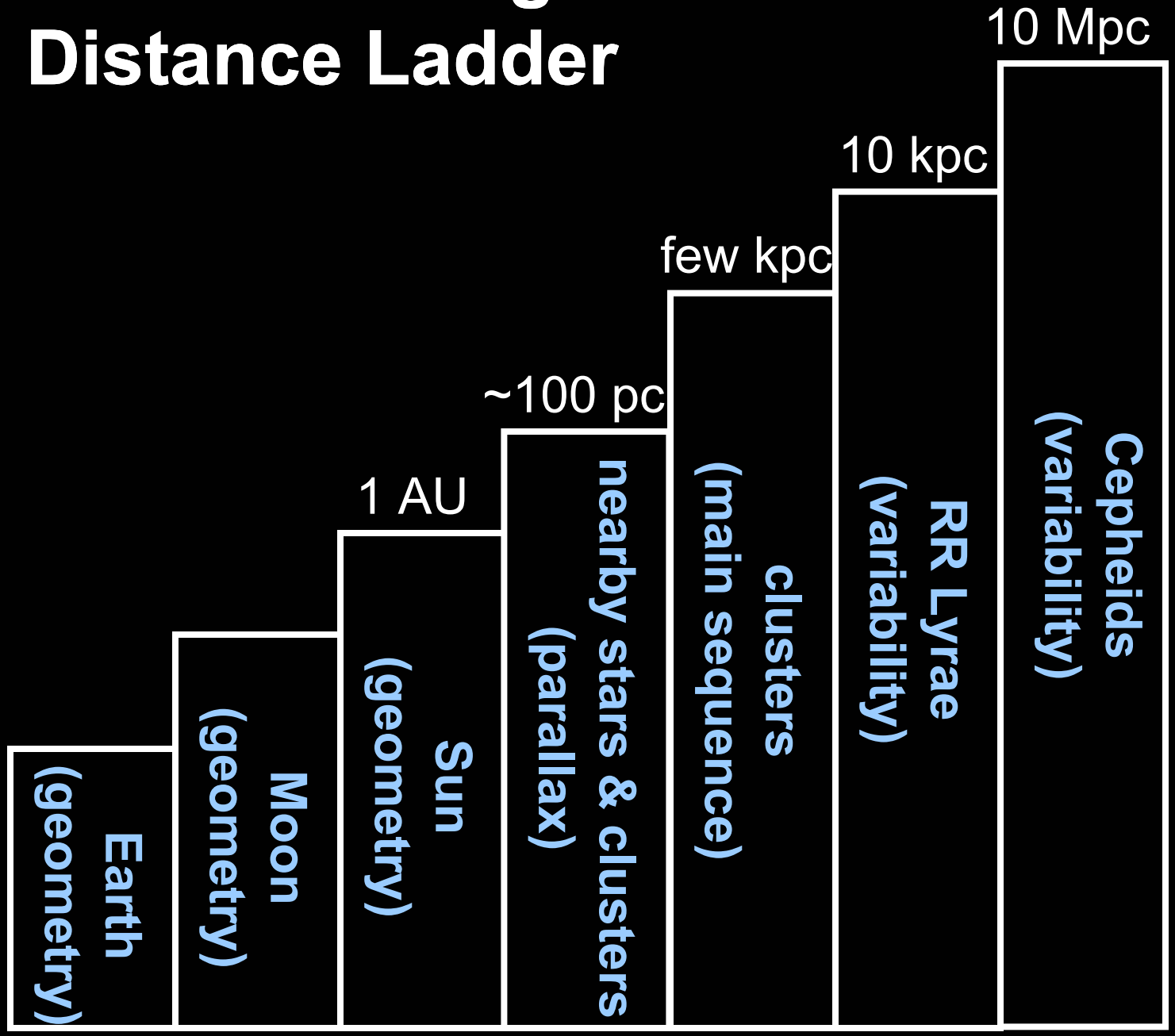
Will Palomar's 200-inch eye see an exploding universe?

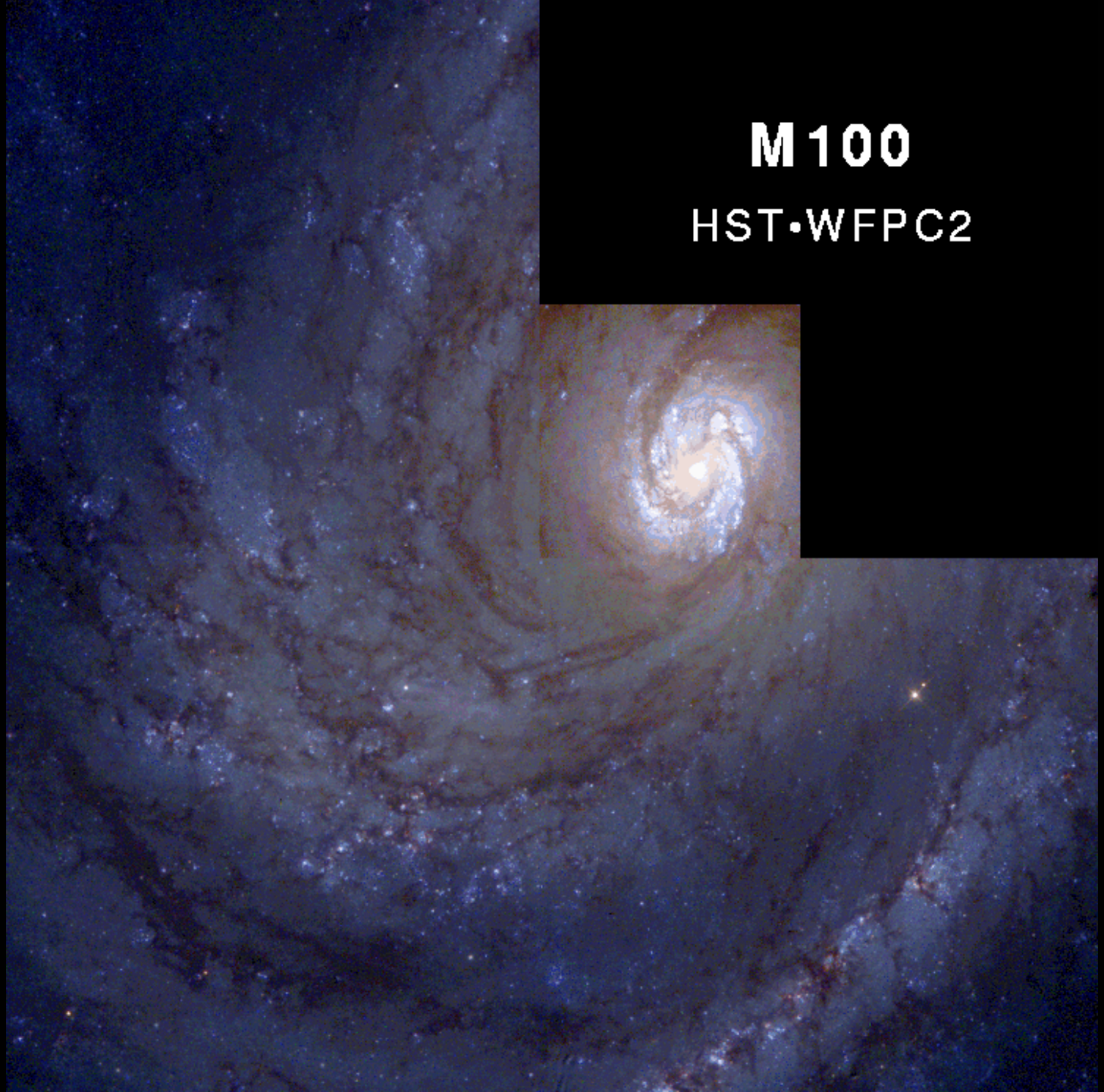
(Science)

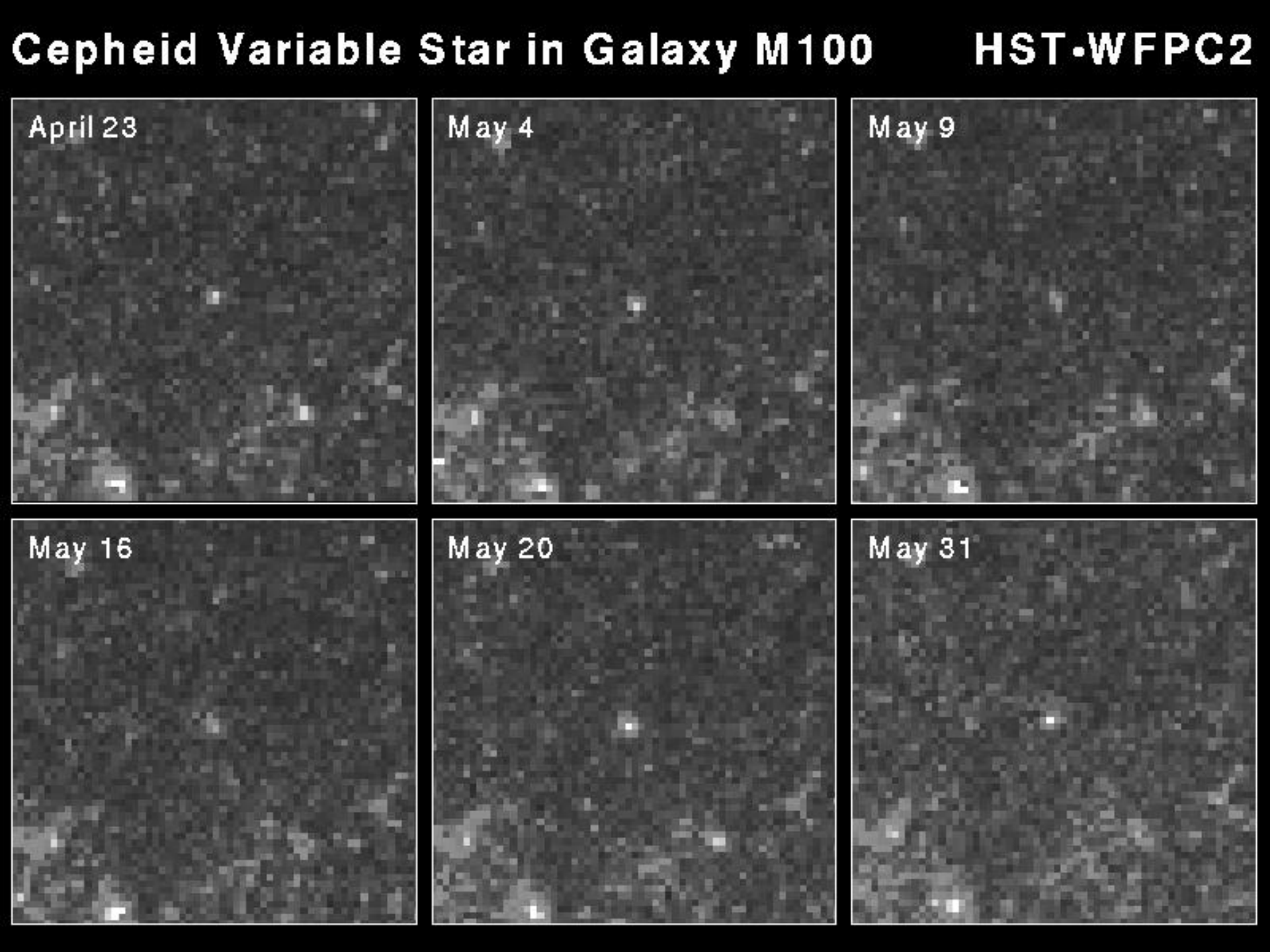
ANDROMEDA
GALAXY


N
VAR!
N
6-Oct
1923
N

The Cosmological Distance Ladder



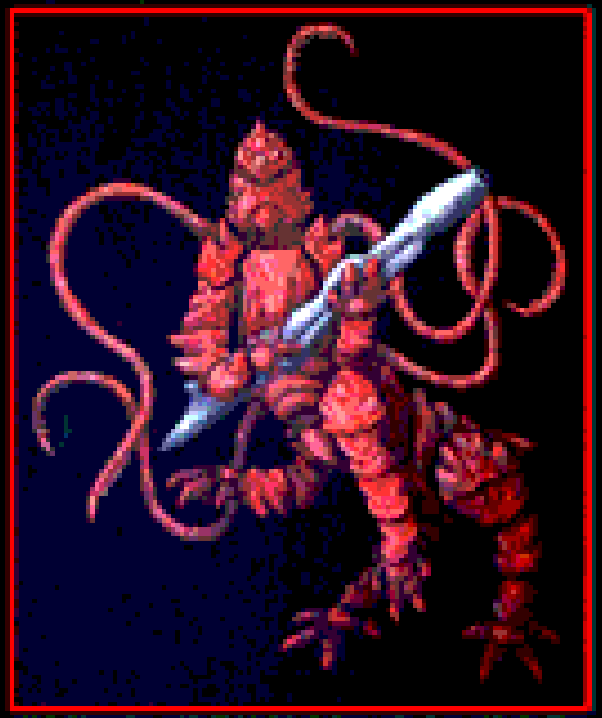

M100
HST•WFPC2


Cepheid Variable Star in Galaxy M100
HST•WFPC2
April 23
May 4
May 9
May 16
May 20
May 31

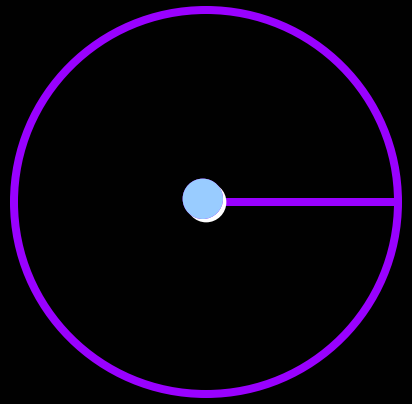
Redshift

REDSHIFT
Second Edition
Science Fiction Roleplaying Game

Equipment Guide



t = Δt

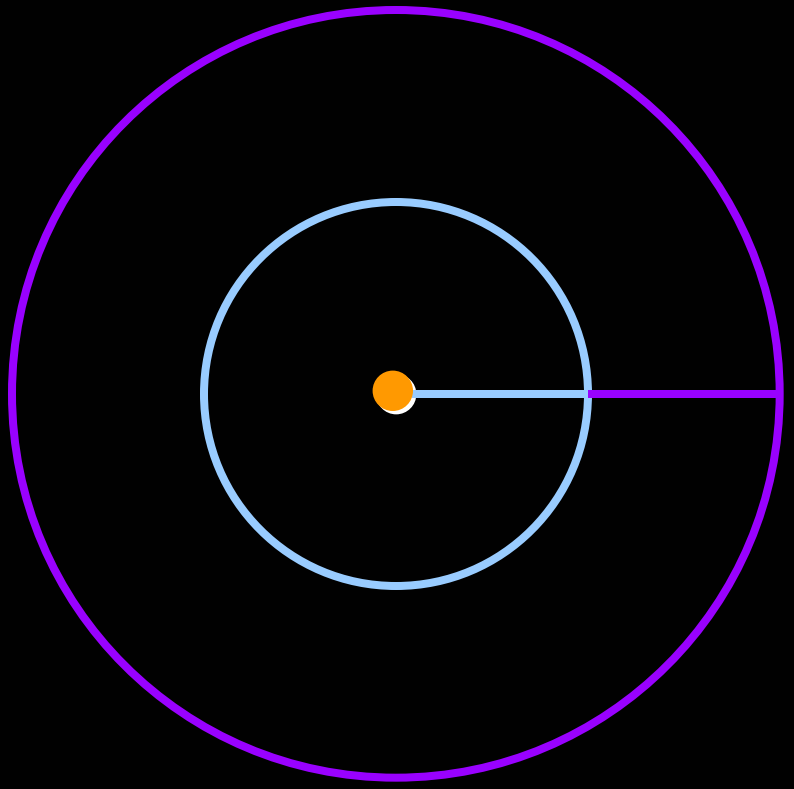


c = velocity of wave

Δt = time difference

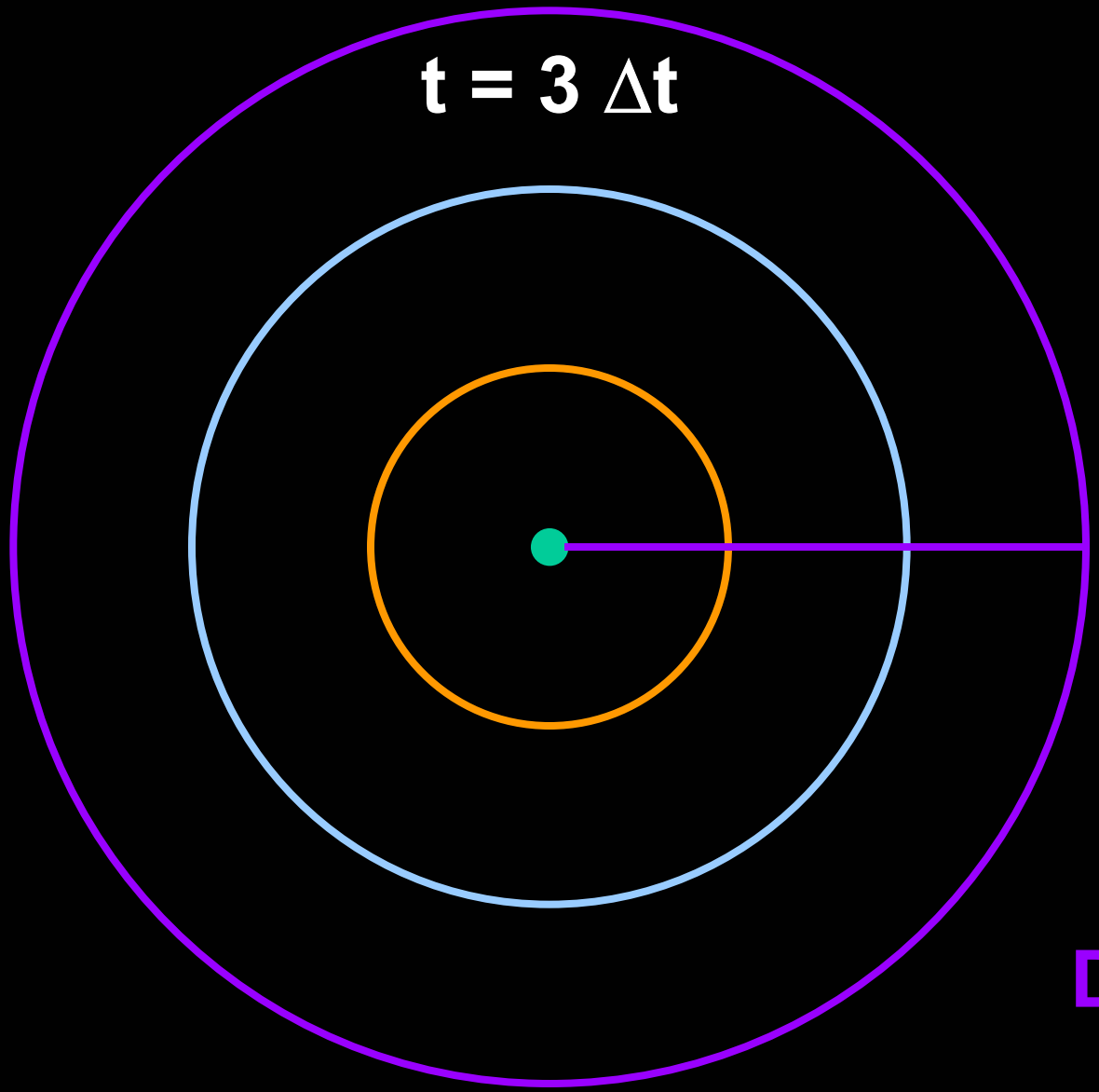
D = c Δt

$t = 2\,\Delta t$



$D = c\,2\,\Delta t$

$D = c\,\Delta t$



$\lambda = c\,\Delta t$

$\lambda = c\,\Delta t$

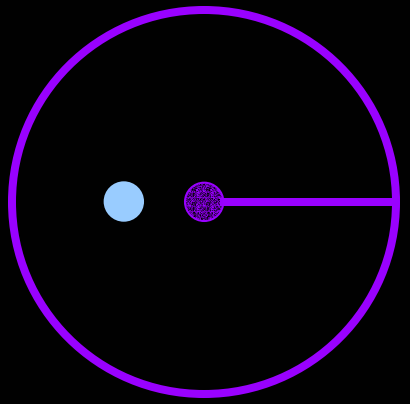
$D = c\ 3\ \Delta t$

$D = c\ 2\ \Delta t$

$D = c\ \Delta t$

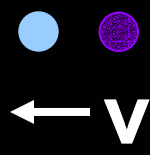
λ = distance between successive wavecrests

$t_t = \Delta t$

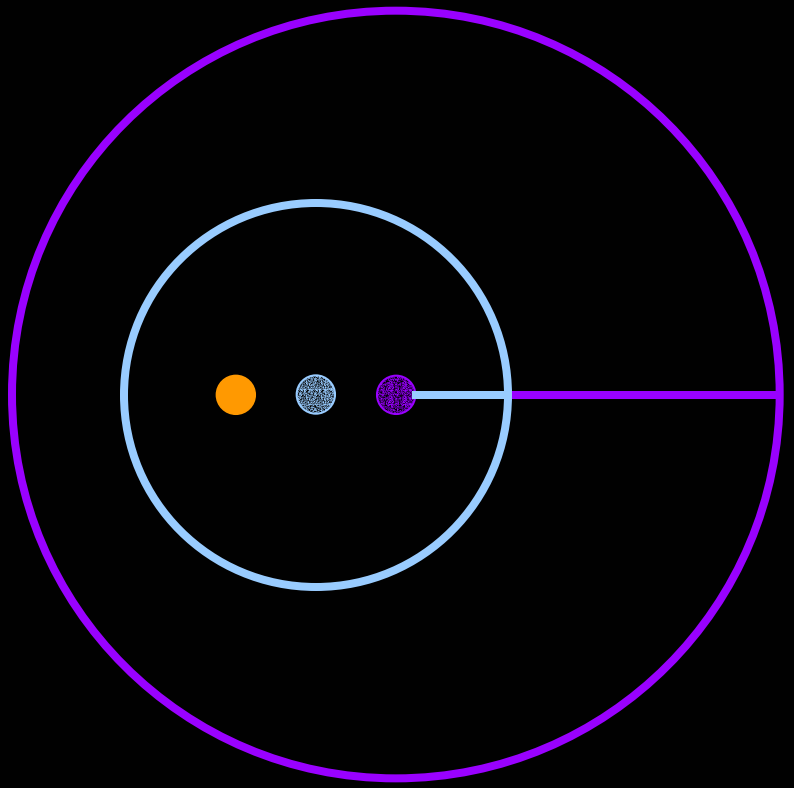


$D = c \quad \Delta t$

$d = v \, \Delta t$

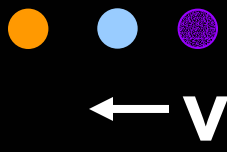


$t = 2\,\Delta t$

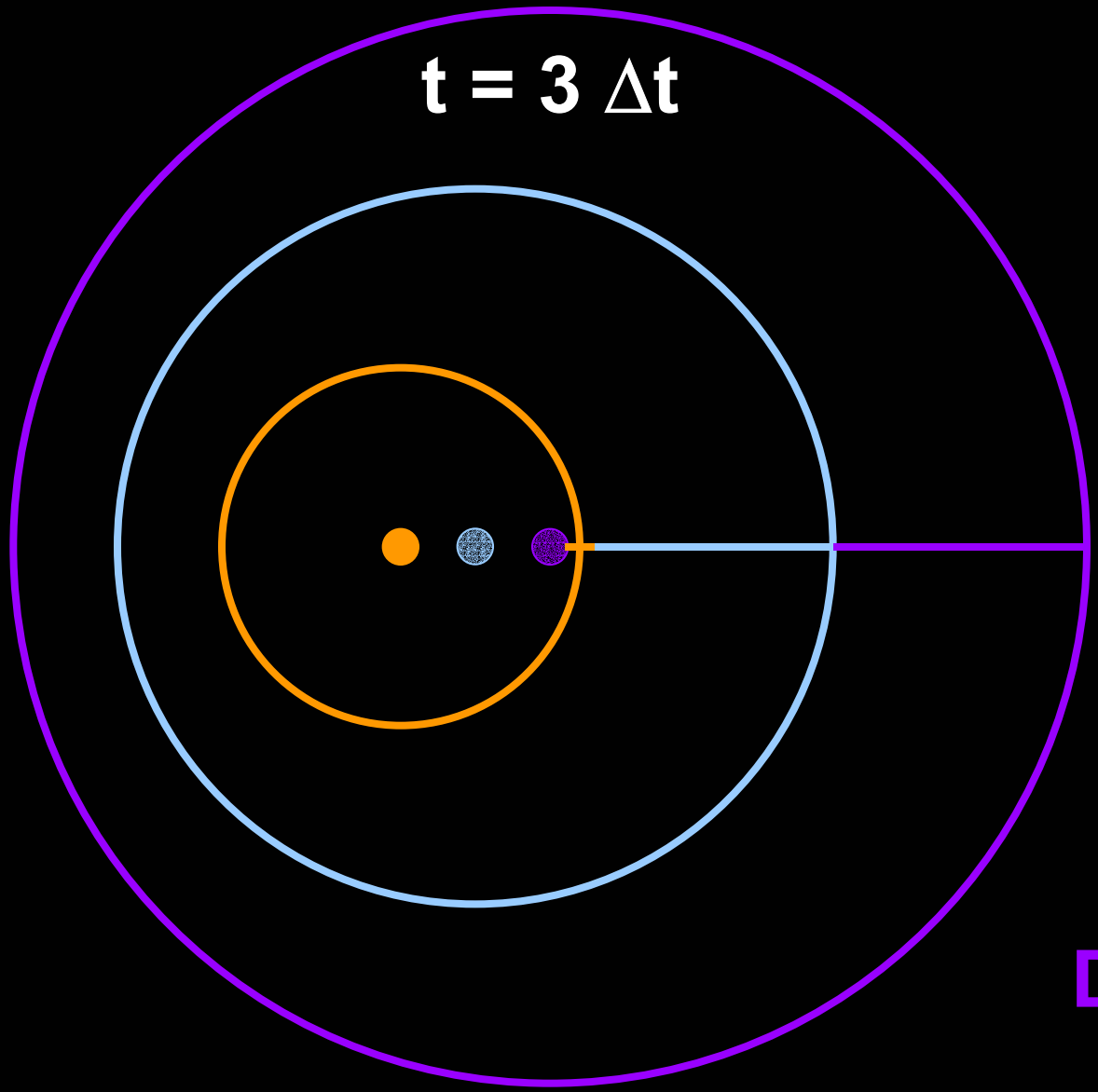


$D = c\ 2\,\Delta t$

$d = v\,\Delta t$



$D = c\ \ \Delta t\ -\ v\,\Delta t$



$\lambda = c\,\Delta t - v\,\Delta t$

$\lambda = c\,\Delta t + v\,\Delta t$

$D = c\ 3\ \Delta t$

$D = c\ 2\ \Delta t\ -\ v\ \Delta t$

$D = c\ \ \Delta t - 2\ v\ \Delta t$

λ = distance between successive wavecrests

$$\lambda = c\,\Delta t \pm \mathrm{v}\,\Delta t$$

$$c\,\Delta t = \lambda_0 \qquad \Rightarrow \qquad \lambda = \lambda_0 \pm \mathrm{v}\,\Delta t$$

$$\Delta t = \frac{\lambda_0}{c} \qquad \Rightarrow \qquad \lambda = \lambda_0 \pm \frac{\mathrm{v}}{c}\lambda_0$$

$$\boxed{\frac{\lambda}{\lambda_0} = 1 \pm \frac{\mathrm{v}}{c}}$$

Frequency

$$c\,\Delta t = \lambda_0$$

$$\frac{1}{\Delta t} = \text{frequency} = \nu_0$$

$$\frac{c}{\nu_0} = \lambda_0 \qquad \frac{c}{\nu} = \lambda$$

$$\boxed{\frac{\lambda}{\lambda_0} = \frac{\nu_0}{\nu}}$$